they terminate in a long acute point in the one case, and in a "long obtuse point" in the other. The reason why, in my former note, I was not in a position to deny positively that these extremely rudimentary organs had lenses, was because, although the 'Porcupine' specimens showed not the slightest trace of lenses, yet, as they had been preserved in glycerine and subsequently transferred to spirit, it was possible that this treatment might have destroyed lenses which had existed.

Mr. Bate inquired whether I could say there were eye-stalks in the young of "*Astacus*? *zaleucus*, Willemoes-Suhm, *Nephropsis Stewartii*, Wood-Mason, and the blind prawns of the North-American caves." Of the first two only the type specimens are known. It is hardly likely, therefore, that I should be acquainted with their young. With respect to the "blind prawns of the North-American caves," I know of no such Crustacea; and suppose that "prawns" was a slip for "crayfish," and that he refers to the *Cambarus pellucidus* of the Mammoth Cave of Kentucky. That crustacean has eyestalks not only when it is young but in maturity also. "Like the other animals living in caves, it is blind. The eyes are atrophied, smaller at the base, conical, instead of cylindical and elongated as in the other species. The cornea exists, but is small, circular, and not faceted; the optic fibres and the dark-coloured pigments surrounding them in all other species are not developed"*.

XXII.—*Notes on the Palæozoic Bivalved Entomostraca.* No. XIII. Entomis serratostriata *and others of the so-called* "Cypridinen" *of the Devonian Schists of Germany.*

By Prof. T. Rupert Jones, F.R.S., F.G.S.

[Plate XI.†]

Introduction.—In the 'Annals and Magazine of Natural History' for June 1873, pp. 413–416, is a list of the species of *Entomis* with which I was acquainted at that date. These included several *Devonian* species from Germany, and *Silurian* species from Bohemia, known to me from figures only, as well as some British *Silurian*‡ and *Carboniferous* species which

* Hagen, *l. c.* p. 33.

† This Plate has been drawn under a grant from the Royal Society for the illustration of fossil Bivalved Entomostraca.

‡ *Entomis aciculata*, op. cit. p. 416, was from Peeblesshire, not the "Pentland Hills."

had come under my notice. Having expressed a difficulty* in mastering the description of figures of the so-called "Cypridinen," published in 1856 ('Beitr. Pal. Thür. Waldes') by my friend Dr. Richter, of Saalfeld, I was most courteously favoured by him with a good set of specimens for examination early in 1874. Some, indeed, of these were types of species published in 1869, in his paper on the Devonian Entomostraca of Thuringia†, which memoir had escaped my observation until after my "Notes on *Entomis*," &c. were printed in 1873. In the meantime, before Dr. Richter's specimens reached me, I was so much struck with the peculiarity of the Entomostracan structures figured in the 'Zeitschrift' of 1869, that I could not but believe some peculiar generic form, occurring in the Thuringian strata, had been elaborated by my friend; and I suggested, in the 'Neues Jahrbuch für Min.' &c. 1874, 2. Heft, p. 180, that his name should be associated with it in the term *Richteria*.

After a long study of Dr. Richter's specimens, having taken them up again and again during the last four years, as new information on analogous and collateral materials become available, I cannot find any reason to support the establishment of my proposed genus "*Richteria*;" for the typical specimens show merely the conformation and characters of *Entomis*; and lately Dr. Richter has informed me that he now refers his so-called "Cypridinen" to that genus.

Description.—Two separable valves, oblong-ovate in outline, ornamented with longitudinal and subconcentric riblets, and impressed externally with a more or less pronounced nuchal or dorsal furrow, ending in a small and often obscure pit at about the middle of the valve, constitute the best preserved remains of the Devonian *Entomides* under notice.

The pressure, both vertical and lateral, to which the Devonian schists have been subjected very rarely leaves these little fossils in their original shape; and the material of the valves has almost always disappeared, leaving hollow external moulds and convex internal casts. The former show the delicate costulation of the valves; the latter are usually smooth and rarely bear any of the external ornament. Flattened by perpendicular pressure, and lengthened, shortened, or otherwise distorted by lateral pressure in different directions, the natural ovate form is seldom preserved, but is replaced by every modification from subcylindrical to circular and obliquc-oval

* *Op. cit.* p. 415, note.

† 'Zeitschrift deutsch. geol. Gesellsch.' Jahrgang 1869, pp. 757–776, pls. xx. & xxi.

shapes. In some cases the dorsal notch is nearly obliterated by vertical pressure; and in other instances it is exaggerated by horizontal squeezing, when the valve becomes shortened to a small subglobular mass, and the two ends of the valve are made to approach each other.

The real outside of a valve is very rare. The convex costulate specimen (fig. 8), even, may be destitute of the external coating. Hollow impressions of the surface, sometimes with remains (or mineral replacements) of the test adhering thereto, are common; and the interior of these moulds usually has the ridge and knob, or some indication of them, which are due to the nuchal incurving of the test. It is possible that on the exterior this feature was not nearly so strong as within, being due as much to a local internal thickening of the substance as to a bending-in of the shell. It was, however, always sufficiently defined to form a weak line when the valves were shortened by being squeezed endwise (see figs. 3, 15, 16).

The convex casts of interiors are destitute of riblets, and sometimes (in the Saalfeld specimens) bear only a central pit, corresponding with the central knoblet of the hollow ribleted moulds. Thus these insides of valves appear to have been smooth, with a small central tubercle, and no definite trace of the external nuchal sulcus, which, however, gives a distinct mark on internal casts of valves bent and shortened by terminal pressure, as mentioned above. In specimens from other localities the smooth convex casts bear the nuchal furrow and no definite central pit.

None of the smooth convex casts with a pit only are figured here, but are recognizable in some of the published illustrations, as in Richter's 'Beitrag' &c. pl. ii. fig. 2.

Many similar smooth convex casts, but bearing the nuchal furrow, are present in a drab mudstone of the "Cypridinen-Schiefer" from Nassau (formerly in Mr. Daniel Sharpe's collection), and are oblong-oval, narrow, oblique, or quite round*, according to the direction of the lateral (horizontal) pressure to which they have been subjected.

The longitudinal wrinkling of the surface of the valves varies in the number, arrangement, smoothness, and thickness of the riblets or costulæ. They may be quite even and smooth (fig. 18 *b*), slightly roughened (figs. 6 *b*, 7 *b*, and 8 *b*), crenulated (figs. 1 *b* and 5 *b*), and even serrated (fig. 4 *b*; see also 'Zeitschr.' 1869, pl. xx. fig. 10). The indentations are sufficiently coarse and defined in some specimens of these hollow moulds

* Such as are figured by Richter, 'Beitrag' &c. pl. ii. figs. 28, 31, and 'Zeitschr.' 1869, pl. xx. fig. 7. See also our figs. 3, 15, 16.

to appear as minute pits, like the bases of hollow spines* (fig. 4 *a*). In the Nassau specimen, referred to above, these little pits are, in many of the hollow casts, very numerous, strong, and regular.

In thickness the riblets vary considerably; so that we may count 36 on some valves (figs. 2, 6)—and on others, of about the same size, 30 (fig. 4), 28 (fig. 9), 22 (fig. 8), 20 (fig. 18), 18 (fig. 11), 16 (fig. 12). On smaller valves, with the *thin riblets*, we find 22 (fig. 5), 18 (fig. 14), 16 (fig. 13); and on a small valve of the *thick-wrinkled* kind there are 18 (fig. 10).

As to the arrangement of the riblets, the typical pattern is a parallel longitudinal folding, with turns of the middle riblets (either backwards and forwards, or irregularly concentric) near the ends of the valves, and a continuous concentric wrinkling at the margins. There are usually two terminal centres of curves or folds; but they may be modified or obliterated by pressure. The whole series of riblets in some cases appears to be naturally subcircular and concentric (figs. 2, 6, 9).

The differences in *essential* characters among these Devonian *Entomides* cannot be regarded as very great. The modifications of shape can be recognized as distinctive only in so far as some specimens (such as figs. 1, 2, 5, 7, 13, 14) are more elongate and almond-like than others. Pressure in several directions has interfered with the outlines, often to a puzzling extent. The sculpturing has many gradations of pattern. Perhaps the only tangible distinctions are:—(1) between the valves with strong (figs. 4, 8, 10, 11, 12, 18), and those with feebler riblets—the former kind usually accompanying the oblong, and the latter the almond-like shape of valve; (2) among the latter, between the parallel (figs. 1, 5, 7, 13, 14) and the concentric arrangement of the costulation; (3) among the last, between the almost simple concentric (figs. 2, 6) and the more labyrinthic (fig. 9) pattern.

I have not been able to make out the intimate structure of the valves as described and figured by Dr. Richter in the 'Zeitschr.' 1869; nor can I agree with the determination there given of their parts and features. The "back-views" of the test are to me the side-views of individual valves, not showing the nuchal furrow, either because it is wanting on the outside of the valve (?), or because it is obsolete or obliterated by pressure. The suborbicular forms, shortened by pressure from end to end, were referred to in the memoir as "female" individuals, and the nuchal or dorsal furrow as a transverse

* Such a spinous surface, indeed, is indicated in Richter's 'Beitr. Pal. Thür. W.' pl. ii. f. 34; *C. gyrata*, p. 36.

ventral slit (like the opening of the hood in some Phyllopods), crossed by a bridge of shell-matter. Dr. Richter's views of the relationship of the so-called "Cypridinen," described and figured in the 'Zeitschrift' for 1869 are there given with some doubt; and we now know (see above, p. 183) that he refers them to *Entomis*.

EXPLANATION OF PLATE XI.

Fig. 1. Concave cast, with faint knob and ridge (the latter extended by pressure). Furrow-casts interrupted by slight indentations due to the serrulation of the riblets. Richter's pl. xx. fig. 10 (Zeitschr. 1869) makes the nearest approach to the typical interruption of the furrow-casts. This specimen (referred by Dr. Richter to "*C. serratostriata*"), is in a red schist, with many casts, hollow and raised, elongate, oval, and round.

Fig. 2. Concave cast, squeezed so as to give the furrow-casts a lozenge-shape arrangement. On similar schist to that of fig. 1, and referred to the same species. It may be the same as fig. 6 ("*tenella*"), or possibly fig. 9 ("*labyrinthica*").

Fig. 3. Convex smooth cast (marked with sand-granules only) of a valve squeezed up endways on itself, with the nuchal depression exaggerated by the pressure, and a mark below of the test broken across. With fig. 1, and referred to the same species.

Fig. 4. Shallow concave cast, with faint irregular knob and ridge. The furrow-casts are much interrupted by what seem to be the bases of external spines, along the internal lines. On reddish-grey schist. This is referred by Dr. Richter to "*C. gyrata*."

Fig. 5. Small hollow cast, with ridge and slight knob. On red schist, with numerous casts, both raised and sunken, long, oval, and round. On this hand-specimen occur such smooth convex casts, with central pit, as that shown in Richter's 'Beitrag,' pl. ii. fig. 27. Referred to "*C. scrobiculata*, Richter," but probably *E. serratostriata*.

Fig. 6. Hollow casts of a pair of opened valves, with ridges within, which represent the nuchal furrow of each valve. In dull purplish-red schist. Referred to "*C. tenella*, Richter," but corresponding in some respects with "*C. labyrinthica*," Richter (see fig. 9). The smoothness of the delicate costulæ and their circular arrangement may be distinctive features; but, on the other hand, these may possibly be modifications from pressure. The figured "*tenella*" ('Zeitschr.' 1869, pl. xx. fig. 11) has concentric riblets; but they are pitted.

Fig. 7. Hollow cast (somewhat crushed) with ridge and knob. In dark-grey schist, with both concave and convex casts, variously squeezed. Referred to "*C. tæniata*, Richter," but probably *E. serratostriata*.

Fig. 8. Convex, somewhat flattened, cast; in purplish-grey schist, with both raised and hollow casts, but low and shallow. Riblets strong and slightly serrulate. Referred to "*C. gyrata*, Richter."

Fig. 9. Shallow hollow cast, with the furrow-casts much modified by pressure. In pale purplish-grey schist, with a few shallow and imperfect casts. Referred to "*C. labyrinthica*, Richter," with the figure of which (in 'Zeitschr.' 1869, pl. xx. fig. 12) it

agrees as to the branching and anastomosing of the concentric costulæ.

Fig. 10. Small, oblong, hollow, cast, with ridge reaching all across, owing to unequal pressure. Furrow-casts broad; internal lines here and there showing indications of bases of spines. On reddish schist, with many modified casts. Referred to "*C. tæniata*," and somewhat corresponding with 'Zeitschr.' 1869, pl. xxi. fig. 1, but unlike our fig. 7, which is referred to the same.

Figs. 11, 12. Hollow casts, with ridges and knobs faint; furrow-casts broad; costulæ thin and slightly irregular. In dark purplish-red schist, with similar casts, variously modified as to shape by pressure, and with numerous inner and outer moulds of annulated Tentaculites. Fig. 11 shows a specimen somewhat shortened by pressure. These are referred to "*C. serratostriata*," but apparently belong to the more oblong form, with coarser furrows, which more nearly corresponds with *Entomis gyrata* (Richter).

Figs. 13, 14. Small, almond-shaped, hollow casts, much like fig. 5, and on the same hand-specimen. Referred to "*C. scrobiculata*," but probably belonging to *E. serratostriata*.

Fig. 15. Outline of a small smooth cast of a shortened valve; others of a larger size occur on the same slab, which bears also the specimens figs. 5, 13, 14, 16. Referred to "*C. scrobiculata*," but probably belonging to *E. serratostriata*.

Fig. 16. Small, convex, smooth, subglobular cast, of a squeezed-up and shortened valve, with central pit and furrow, exaggerated by terminal pressure. On the same piece of red schist as that yielding figs. 5, 13, 14, 15. Referred to "*C. scrobiculata*;" probably *E. serratostriata*.

Fig. 17. Outline of a broken hollow cast of the dorsal edge of two united valves, with a slightly raised seam along the junction of the valves, and a very faint cross ridge. In reddish-grey schist, weathering brown, with Tentaculites, and numerous casts, both raised and hollow, of *E. serratostriata*. The specimen is marked "Ventralseite von *C. tenella*;" but it is the dorsal, and not the ventral, edge of the closed carapace of the common *Entomis*.

Fig. 18. Shallow hollow cast, with remains of the test; furrow-casts and lines quite smooth and sharp. In dark schist, with scattered portions of other similar copper-red tests, or their replacement by mineral matter (iron oxide?). Marked "*C. costata*," but differing considerably from pl. xx. fig. 15, 'Zeitschr.' 1869. It is not very distinct from our figs. 4, 8, 10, 11, 12, except that the costulæ are smoother and make two folds near one end of the valve, a pattern obscurely traceable in fig. 4.

Conclusion. We may conclude, as far as the present evidence permits, that figs. 1, 3, 5, 7, 13, 14, 15, 16, and 17 belong to *Entomis serratostriata* (Sandberger), figs. 2 and 6 to *E. tenella* (Richter), fig. 9 to *E. labyrinthica* (Richter), figs. 4, 8, 10, 11, 12, and 18 to *E. gyrata* (Richter).